

ELECTRONIC FUNDAMENTALS

THEORY LESSON 2

SCHEMATIC SYMBOLS AND HOW TO USE THEM

- 2-1. Schematic Symbols
- 2-2. Special Cases
- 2-3. Schematic Diagrams



RCA INSTITUTES, INC.

**A SERVICE OF RADIO CORPORATION OF AMERICA
HOME STUDY SCHOOL**

350 West 4th Street, New York 14, N. Y.

Theory Lesson 2

INTRODUCTION

You have probably noticed that radio and TV sets have many parts. Different models have parts arranged in different ways. If you were asked to describe all the parts of a radio or TV set and how they are connected together, you would find it difficult to put in words. Even if you succeeded, your description would probably be very long. Yet there is a need for descriptions of radio and TV circuits. When an engineer working for a manufacturer designs a new receiver, he must be able to give the production department, which actually makes the set, all the details of how it is to be put together. After the set has been placed on the market, the servicemen who will keep the set in repair must know how the radio or TV set is put together and what components it uses.

The details of a radio, for example, might be shown by photographs of the set. Figure 2-1 uses this method, showing how parts are connected together in the radio receiver you will assemble later in this course. But this method, while it has its uses, is not practical for showing all the

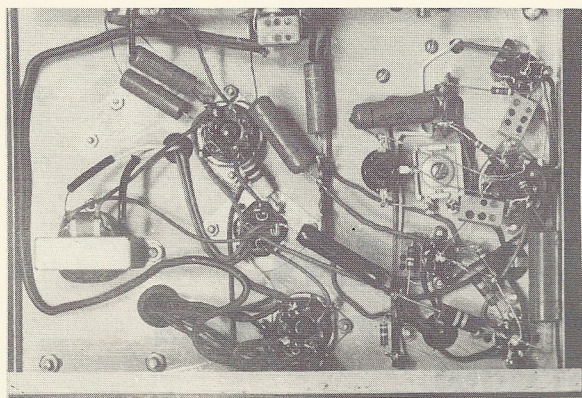


Fig. 2-1

connections and parts in a radio receiver. If you have ever examined the underside of a radio chassis, you will understand why. In many cases, parts are placed above one another, and some of the parts and some of the connections are hidden from view.

Using another method, we could take pictures of the radio parts and, by drawing lines between the parts, show how they are connected together. In fact, such a method is used frequently in factories to show the people who wire the chassis how the parts are to be connected. We call such a diagram a *wiring diagram*. Figure 2-2 shows a wiring diagram of a small audio amplifier. Such a diagram is very helpful when assembling the amplifier, but it is not of much use in trying to understand the operation of a new circuit.

2-1. SCHEMATIC SYMBOLS

Engineers, technicians, and servicemen make use of symbols to represent the various parts that make up a radio or TV set. Some time or other, you may have returned from a hike or trip and wanted to tell a friend about it. Probably you drew a map, because you found that it was much easier to tell about your trip with a map than to use only words. In much the same way, an engineer draws something like a map of the circuit that he designs. Just as the map-maker has certain symbols that stand for certain types of roads, county boundaries, bridges, and other parts that make up a map, so the engineer uses symbols to represent the parts that make up a radio or TV set. Such symbols were used to draw the circuit diagram, shown in Fig. 2-3, of the audio amplifier that you saw in Fig. 2-2.

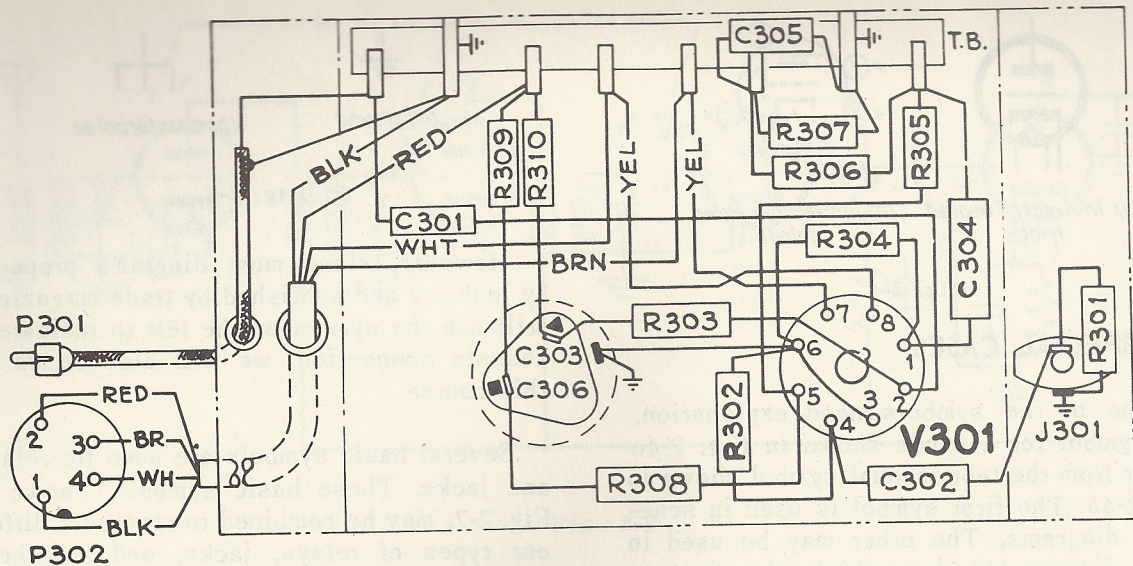


Fig. 2-2

In Experiment Lesson 3, in many lessons to come, and in your work after you complete the course, a knowledge of symbols and how to read circuit diagrams is necessary. A well-drawn circuit diagram, or *schematic*, as it is often called, can be very helpful in enabling you to understand circuits and to locate receiver troubles. As you learn more and more about electricity and electronics, you will appreciate how useful a good circuit diagram really is.

All of the symbols that you are likely to find in radio and TV receiver diagrams have been included in this lesson. A list of many common symbols appears at the end of this lesson. At the time this lesson was written,

they were recognized as standard for the radio and TV industry. But, standards tend to change, so it is a good idea to check up from time to time on any new changes that may be made. The source of most of the symbols shown in this lesson is the Institute of Radio Engineers, one of the foremost professional radio organizations in the world. These symbols are in agreement with those recommended by the American Standards Association and the Army-Navy-Air Force standards. Right now, some of the symbols will not mean much to you. Don't worry about it; the more you learn of radio and television, the more of the symbols you will remember. Finally, you will recognize them as easily as you recognize the words you're reading now.

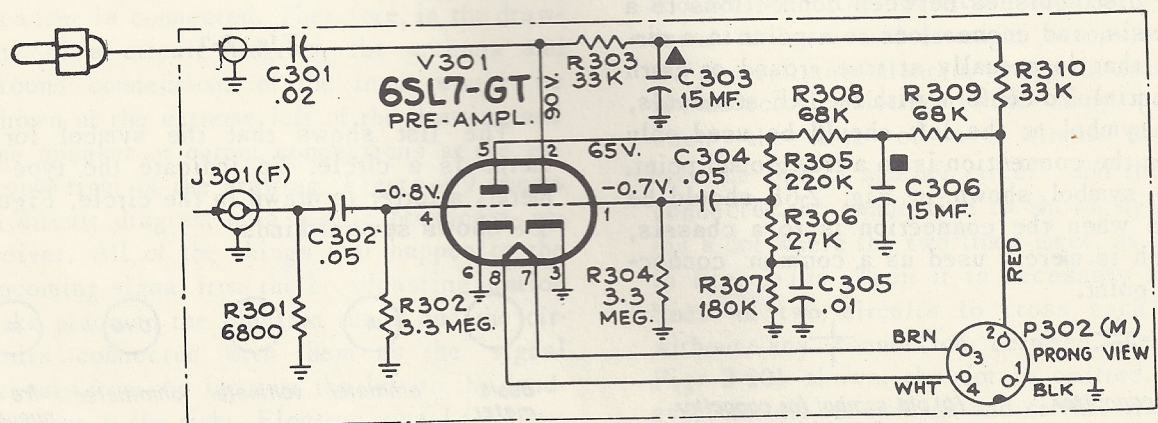


Fig. 2-3

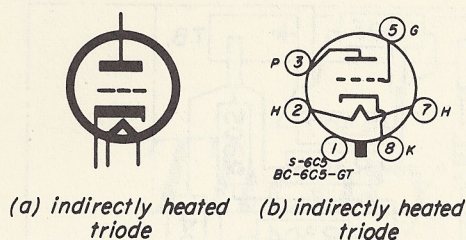


Fig. 2-4

2.2. SPECIAL CASES

Some of the symbols need explanation. The symbol for a triode shown in Fig. 2-4a differs from the tube manual symbol shown in Fig. 2-4b. The first symbol is used in schematic diagrams. The other may be used in wiring diagrams to show which tube pin connects to each tube element and also how they are arranged around the socket.

The present symbol for a capacitor looks like Fig. 2-5a. You may find a capacitor symbol that looks like Fig. 2-5b. This symbol is now used to show an open contact in a switch or simple relay. This change will not cause you much confusion. You will soon know enough about circuits to tell what the symbol stands for.

The symbol shown in Fig. 2-6a is in common use as a "ground symbol", that is, a point to which many common connections are made. The chassis is usually used for these common connections, and the symbol in Fig. 2-6a is in general use to signify the chassis.

The Institute of Radio Engineers (IRE) now distinguishes between connections to a chassis, and connections to a point in a circuit that is actually at true ground or earth potential. To conform with the IRE standards, the symbol at the left should be used only when the connection is to a true ground point. The symbol shown in Fig. 2-6b should be used when the connection is to a chassis, which is merely used as a common connection point.

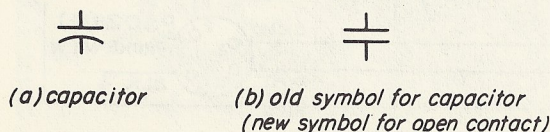


Fig. 2-5

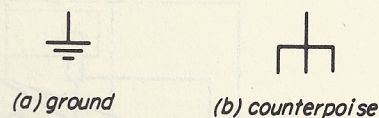


Fig. 2-6

However, since most diagrams prepared by industry and published by trade magazines still use the symbol on the left to indicate a chassis connection, we will also do so in this course.

Several basic symbols are used for relays and jacks. These basic symbols, shown in Fig. 2-7, may be combined to represent different types of relays, jacks, and switches. There are so many different kinds manufactured that it is practically impossible to show them all, so only a few are shown in the list of symbols. The basic symbols are shown so that you may know what each part stands for, no matter how they are put together.

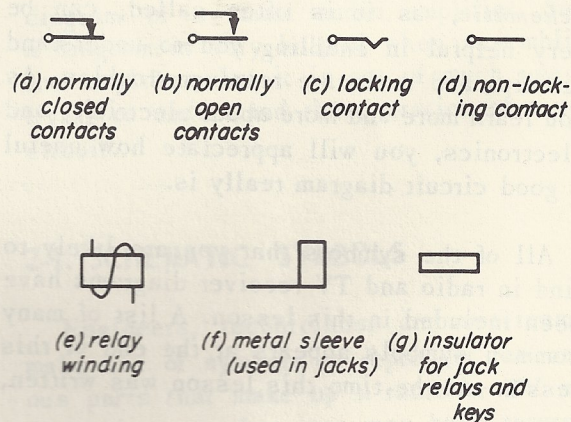


Fig. 2-7

The list shows that the symbol for a meter is a circle. To indicate the type of meter, a letter is drawn in the circle. Figure 2-8 shows several kinds.

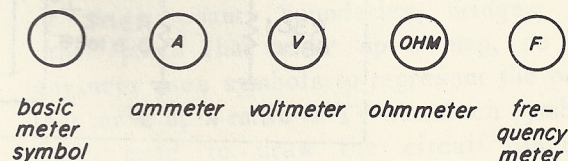


Fig. 2-8

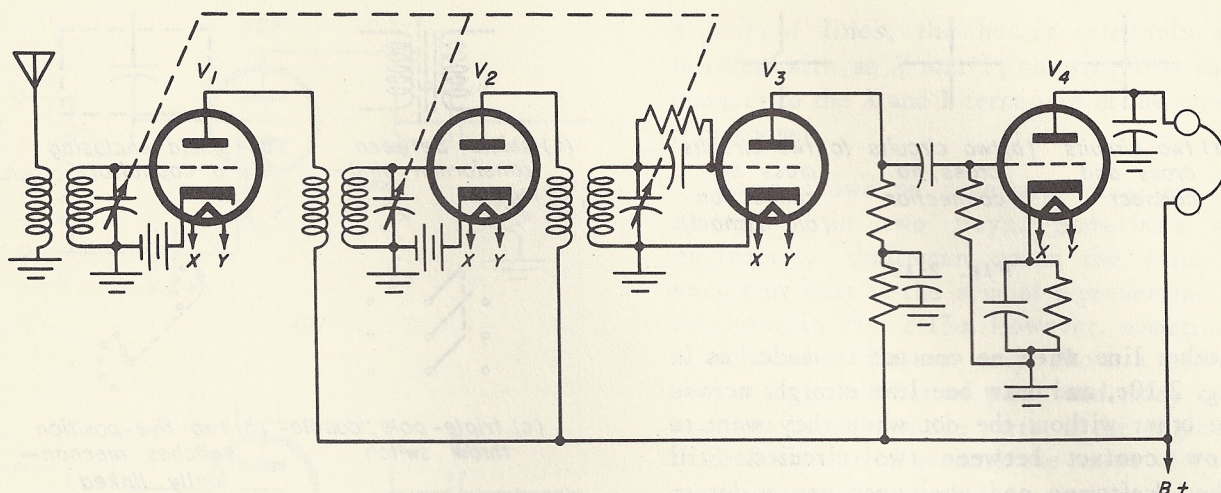


Fig. 2-9

2-3. SCHEMATIC DIAGRAMS

Actually, nobody has yet made up strict rules for the use of circuit symbols in circuit diagrams. There are, however, certain methods of putting together symbols that most engineers and engineering draftsmen follow. These unwritten rules are few and easy to understand.

1. Schematics or circuit diagrams should read from left to right. Each piece of electronic equipment has an *input* and an *output*. For example, the input to a radio receiver would be either a built-in antenna or the leads or binding posts that connect it with the outside antenna or ground wires. The output of the same receiver would be either a built-in speaker, where there is one, or the jack or binding posts to which the speaker or headset is connected. Therefore, in the drawing of a circuit diagram, the antenna and ground connections of the input would be shown at the extreme left of the drawing and the speaker or output connections at the extreme right of the drawing. Figure 2-9 shows a circuit diagram of a simple broadcast receiver. All of the things that happen to the incoming signal from the broadcasting station take place in the electron tubes and the circuits connected with them as the signal travels from the input at the left to the loudspeaker at the right. Electron tube 1 receives the signal and passes it on to tube 2, through 3, and then 4, before it reaches the headset.

2. In many cases, the symbols for the parts of a receiver that normally appear near the top of the receiver chassis, such as antenna, electron tubes, r-f transformers, and loudspeaker, are shown near the top of the schematic. Parts normally found in the underpart of the chassis are usually shown in the lower portion of the schematic. For example, a circuit diagram for a commercial radio receiver that showed the antenna at the lower part of input and the ground at the upper part of the input would be very unusual. Sometimes, however, it is not possible to show all of the electron tubes and parts that appear at the top of the chassis at the top of the circuit diagram. There are times when the draftsman finds it more convenient to place them elsewhere.

3. Lines that connect one symbol with another are either vertical (straight up and down) or horizontal (straight across). They are generally not slanted, except in drawings of selector switches with many points. When the line of one circuit crosses over the line of another circuit and they are connected, the connection is shown by drawing a dot where the two lines meet, as shown in Fig. 2-10a. When it is necessary for the lines of two circuits to cross each other without any connection between them, as Fig. 2-10b shows, the dot is omitted. However, not all schematics and circuit diagrams agree with this standard. Some draftsmen and engineers draw a curve when crossing

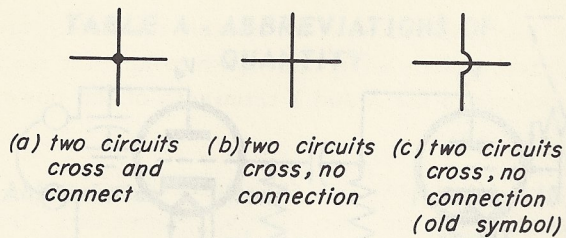


Fig. 2-10

another line when no contact is made, as in Fig. 2-10c, and draw one line straight across the other without the dot when they want to show contact between two circuits. Still other draftsmen and engineers use a dot to show a connection and a little curve to show no connection between two circuits. Usually you can tell which system is being used by noticing which combination of dots, little curves, or lines simply crossing each other is being used.

4. A dashed or broken line is used to show a metal shield between two parts or

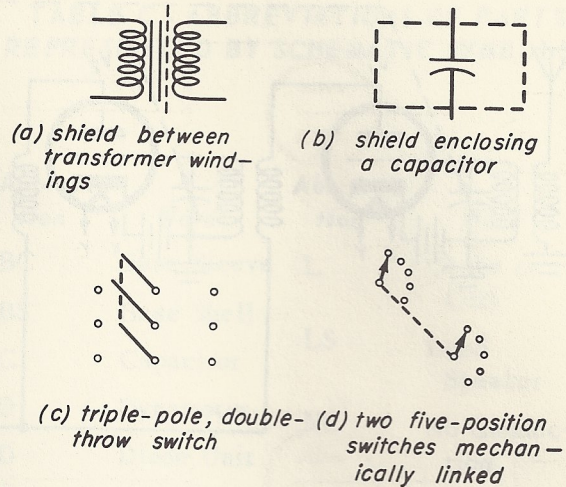


Fig. 2-11

two sections of one part, as shown in Fig. 2-11a, or is drawn around a part to show a shield enclosing a part, as in Fig. 2-11b. A broken line is also used to show mechanical linking between two or more parts. For example, the tuning capacitor of a radio receiver may have two, three, or more sec-

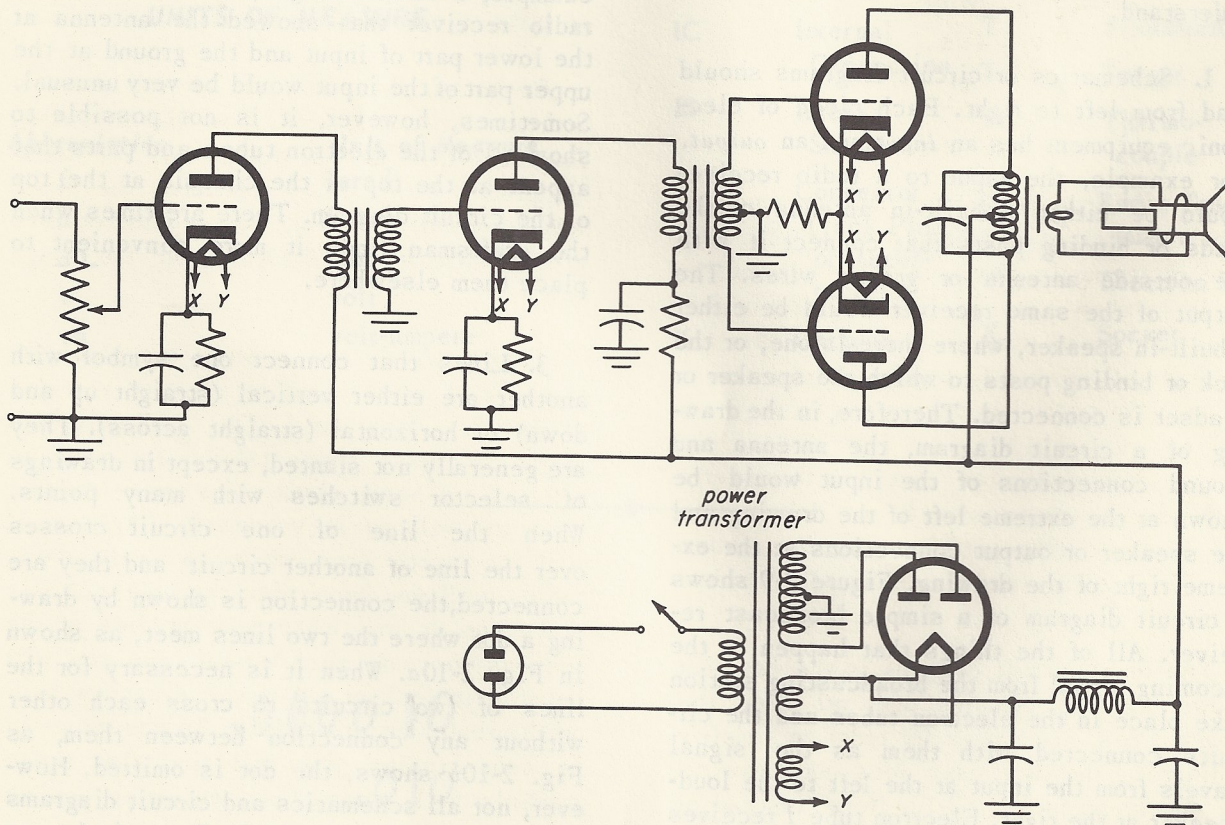


Fig. 2-12

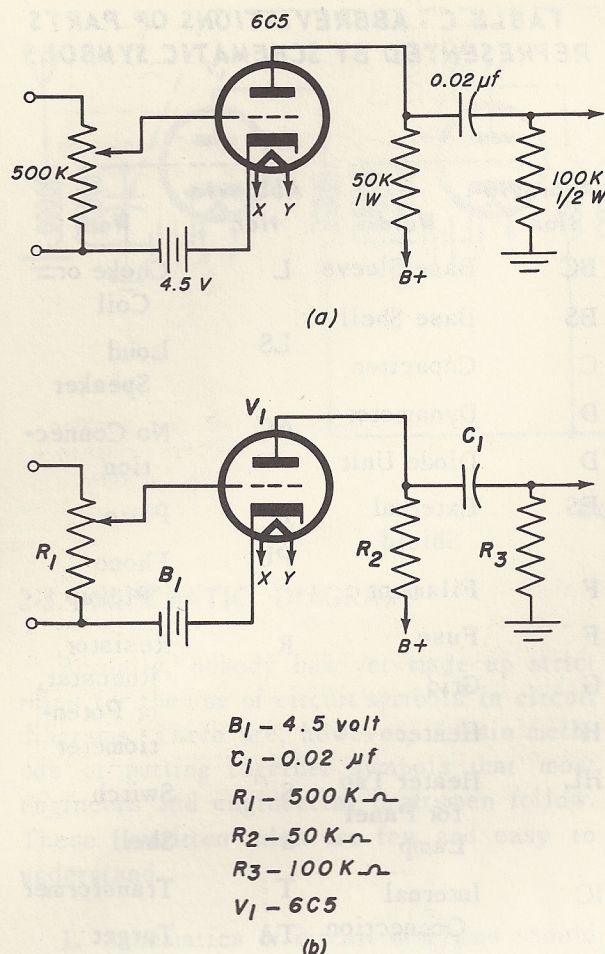


Fig. 2-13

tions. All of these sections may be tuned by one knob that is attached to one shaft. This type of tuning is shown in some schematics as it is shown in Fig. 2-9; slanted broken lines are drawn from all the parts that are mechanically linked (ganged) to some common point. This method is often used to show the linking of switches. In Fig. 2-11c, the broken line indicates that the three parts of the double throw switch are linked. The two separate five position switches shown in Fig. 2-11d are mechanically linked switches.

The ideal circuit diagram is the one that shows all the circuits and yet uses the fewest lines. Sometimes, in order to simplify a diagram, the draftsman does not show all the wires, as in Fig. 2-12. Here, instead of connecting all the electron tube heaters with

a pair of lines, the heater terminals are lettered with an X and Y, showing that they connect to the X and Y terminals of the power transformer.

Parts shown on schematic diagrams are identified in two ways. Sometimes the engineer or draftsman marks the value of each part next to the symbol representing it, as shown in Fig. 2-13a. However, sometimes a schematic diagram may show a circuit with a large number of parts and many connections between these parts. If the engineer or draftsman tried to mark the value of each part next to the symbol representing it, he would find that he had cluttered up the drawing so much that it was difficult to read. In such cases, the symbols are given a letter abbreviation and number. The number and letter given to each symbol are identified in a parts list that is printed in a clear space on the schematic diagram, as shown in Fig. 2-13b. This second method is not as convenient as the first method for the person who tries to learn the part values. However, sometimes there is no other convenient way to make a schematic diagram.

Remember that there are no set rules for making circuit diagrams. You will find many diagrams that do not follow all the ideas suggested here. Once you have the basic idea of circuit diagrams, you should not have great difficulty in figuring out the tough ones.

Tables A, B, and C show the abbreviations most often used to identify parts in schematic diagrams. The abbreviations given in these three tables are used in articles and books about radio and television work as well as in schematic diagrams. It will be worth your while to study these tables until you know what the abbreviations stand for. It will make your studies of the lessons to come much easier, and you will be able to look at schematic diagrams with much greater understanding. As you progress in your studies, you will find that these symbols will become as familiar to you as many words you use every day.

TABLE A - ABBREVIATIONS OF QUANTITY

Abbreviation	Word	Power of 10
$\mu\mu$	micromicro	10^{-12}
μ	micro	10^{-6}
m	milli	10^{-3}
c	centi	10^{-2}
K or k	Kilo	10^3
M	Mega	10^6
KM or kM	Kilomega	10^9
MM	megamega	10^{12}

TABLE B - ABBREVIATIONS OF UNITS OF MEASURE

Abbreviation	Unit of Measure
f	farad
h	henry
Ω	ohm
v	volt
va	volt-ampere

TABLE C - ABBREVIATIONS OF PARTS REPRESENTED BY SCHEMATIC SYMBOLS

Abbreviation	Word	Abbreviation	Word
BC	Base Sleeve	L	Choke or Coil
BS	Base Shell	LS	Loud Speaker
C	Capacitor	NC	No Connection
D	Dynamotor	P	Plate
D	Diode Unit	PU	Phono Pickup
ES	External Shield	R	Resistor, Rheostat, or Potentiometer
F	Filament	S	Switch
F	Fuse	S	Shell
G	Grid	T	Transformer
H	Heater	TA	Target
HL	Heater Tap for Panel Lamp	TC	Thermocouple
IC	Internal Connection	TR	Radio Transmitter
IS	Internal Shield	V	Electron Tube
J	Connector (Jack, Plug, or Receptacle)	X	Socket
K	Cathode		

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APPENDIX

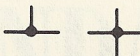
COMPONENT	SYMBOL	COMPONENT	SYMBOL
Antenna		Core	
general		air	no symbol
counterpoise		iron	
dipole		non-ferrous metal	
loop		powdered iron	
Arrester, lightning		variable or movable core	
Battery		Crystal	
single cell		detector	
multicell		piezoelectric	
Cable		source of a.c.	
coaxial		Fuse	
2 conductor cable with shield grounded		Ground	
Capacitor		Headphone	
general		single	
electrolytic		double	
split stator variable		Inductor	
variable		fixed	
variable with mechanical linkage		magnetic core	
NOTE: The curved element represents the outside electrode in fixed paper dielectric and ceramic dielectric capacitors, the negative electrode in electrolytic capacitors, and the moving element in variable and adjustable capacitors.		powdered iron core	
When it is necessary to indicate trimmer capacitors, the letter t appears adjacent to the symbol.		non-ferrous metal core	
		shielded	

COMPONENT	SYMBOL	COMPONENT	SYMBOL
variable inductor		Key	
variable core		telegraph	
<i>Jack and Relay</i>		Lamp	
<i>basic elements</i>		illuminating	
contact, moving (non-locking)		resistance (ballast)	
contact, moving (locking)		<i>Meter</i>	
contact, adjustable or sliding		basic symbol	
contacts normally closed		ammeter	
contacts normally open		frequency	
<i>NOTE: Circle is the pivot point for moving contacts for relays, keys, jacks, switches etc.</i>		galvanometer	
sleeve, metal		milliammeter	
insulator for mechanical coupling between moving contacts on jacks, relays, keys etc.		microammeter	
<i>typical jacks & relays</i>		ohmmeter	
jack, 2 conductor		voltmeter	
jack, 3 conductor (closed)		wattmeter	
jack, 3 conductor (open)		<i>Microphone</i>	
relay, inductive		single button	
relay with break contacts		double button	
relay with make contacts		capacitor	
relay, magnetic		crystal	
		moving coil	
		velocity	
		<i>Plug</i>	
		3 conductor (for use with jack)	
		2 conductor (for use with jack)	

COMPONENT	SYMBOL	COMPONENT	SYMBOL
2-conductor not polarized		variable (rheostat)	
2-conductor polarized		variable (potentiometer)	
3-conductor polarized		shield	
Receptacle		general	
2-conductor not polarized		enclosing	
2-conductor polarized		grounded	
3-conductor polarized		Speaker	
Rectifier (not electron tube)		general	
half wave		electromagnetic (moving coil)	
full wave (bridge type)		permanent-magnet (moving coil)	
NOTE: Arrow indicates direction of forward (conventional) current flow. The lines represent the cathodes and the arrows, the anodes.		electromagnetic with moving coil and humbucking winding	
Reproducer		switch	
general		key (break)	
crystal		key (make)	
electromagnetic		knife, double pole single throw	
Resistor		knife, single pole single throw	
fixed		knife, triple pole double throw	
tapped, with leads		multipoint	
tapped, with terminals		terminal	
		single	
		strip	

COMPONENT	SYMBOL	COMPONENT	SYMBOL
Transformer			
<i>general</i>		half-wave rectifier (diode) indirectly heated	
<i>magnetic core</i>		twin diode indirectly heated	
<i>magnetic core, variable</i>		twin diode triode indirectly heated	
<i>powdered iron core, variable</i>		tetrode indirectly heated	
<i>multiwinding</i>		pentode indirectly heated	
<i>autotransformer</i>		pentagrid converter	
Tube, electron		half-wave rectifier, beam power amplifier	
	<i>used for schematic diagrams</i>		
	<i>typical symbols used in tube manual and wiring diagrams</i>		
	*		
half-wave rectifier (diode) directly heated			
full-wave rectifier (twin diode) directly heated			
triode directly heated			
triode indirectly heated			
	<i>S-605 8C-605-6T</i>		
		vibrator	
		<i>general</i>	
		<i>reed</i>	

*Very often, the tube elements are not shown in wiring diagrams because the placement of parts and wires across the tube symbol would cover the elements. For example, the elements are not shown in Fig. 2-2.

COMPONENT	SYMBOL	COMPONENT	SYMBOL
wiring			
wires connected		wires omitted (wiring between letters or num- bers is under- stood)	 
wires crossing but not connected			 



EXPERIMENT LESSON 2

HOW TO DO ADVANCED SOLDERING



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